Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

# ARIDITY AND HUMIDITY MAPS OF THE UNITED STATES

## By MARK JEFFERSON

How can we represent simply and clearly what a geographer regards as the essential facts of rainfall—the facts that condition life in the United States? The two accompanying maps are an attempt to answer the question.

The facts of precipitation are taken from the latest rainfall map by Henry Gannett.[1] Gannett's maps of rainfall have always appealed to the writer because they pay attention to mountain contouring and utilize well-ascertained facts about mountain rainfall and vegetation as well as records of rain gages. A rain gage, if properly exposed, may give a good idea of the rainfall of a region after ten or twenty years of observation. Even if badly exposed, as many gages are, it may give some idea of the local precipitation. Likewise a forest in a treeless region hints very definitely at greater rainfall where it stands than roundabout. It is true that a forest cannot tell us how many inches of rain fall in its area, yet if the fall on the treeless lands about it is a little less than some critical amount, as 10 inches, for instance, it would be no indiscretion to draw the isohyet for that value on the mountain. No geographer should hesitate to do so. The meteorologist who declines to do so should entitle his map one of "average gage readings" rather than of "normal precipitation."

That is precisely what the precipitation charts of the Weather Bureau are. Refer, for example, to that in the "Statistical Atlas of the United States," 1914.[2] The Wasatch Range is there marked 15 inches, plus. All the gages are on the lower ground, of course; the highest at Soldier Summit and Ibapah, both places 7,500 feet above the sea. The summits of the Wasatch rise above 12,000 feet. Of the fifty-seven stations where rain is measured in the state of Utah, twenty-two are below 5,000 feet, nineteen between 5,000 and 6,000 feet, nine between 6,000 and 7,000 feet, and seven

---

[1] Scale, 1:16,000,000, Pl. I, *U. S. Geol. Surv. Water-Supply Paper 301*, 1912 (also as Pl. I in each number from 302 to 312, 1912-14). The rainfall curves are drawn for every 5 inches in the interior from the Rockies to the Appalachians, and elsewhere for every 10 inches. The numbers on the curves are too small; indeed, some of them are illegible, and the draftsman has been careless in the Adirondacks and Catskills. Either the line numbered 50 inches should be numbered 40 inches, or a 40-inch line should be added.—M. J.

Gannett's earlier rainfall maps of the United States were published as follows: 1:11,900,000, Pl. I, *U. S. Geol. Surv. Water-Supply Paper 234*, 1909; 1:11,900,000, Pl. 40, *Monthly Weather Rev.*, Vol. 30, 1902; 1:29,000,000, Pl. VI, *U. S. Geol. Surv. 14th Ann. Rept.*, Part II, 1894. The 1912 map has rainfall curves only, the others have tints in addition. The 1909 edition was reproduced as a wall map, 1:3,041,280, by A. J. Nystrom & Co., Chicago, in 1915, although the more complete 1912 version was then available. Another reproduction, 1:33,500,000, in metric equivalents, of the 1909 edition, with modifications along the Canadian border, beyond which it is extended, accompanies, as Fig. 1 on p. 390, a paper by Henri Baulig on run-off and erosion in the United States in the *Annales de Géogr.*, Vol. 19, 1910. The 1894 edition is substantially reproduced in about 1:40,000,000 as Fig. 7, *U. S. Geol. Surv. 22nd Ann. Rept.*, Part IV, 1902, and as Fig. 1, *U. S. Geol. Surv. Water-Supply Paper 257*, 1911. On both these reproductions the arid district of the upper Colorado basin in northeastern Arizona and southeastern Utah is by mistake shaded to indicate 20-30 inches rainfall instead of 0-10 inches.—EDIT. NOTE.

[2] Pl. 389, scale, 1:11,900,000, Bureau of the Census, Washington, D. C., 1914. This map has rainfall curves only; for the same map with tints in addition see Pl. XXVI, *U. S. Weather Bur. Bull. Q*, 1906.

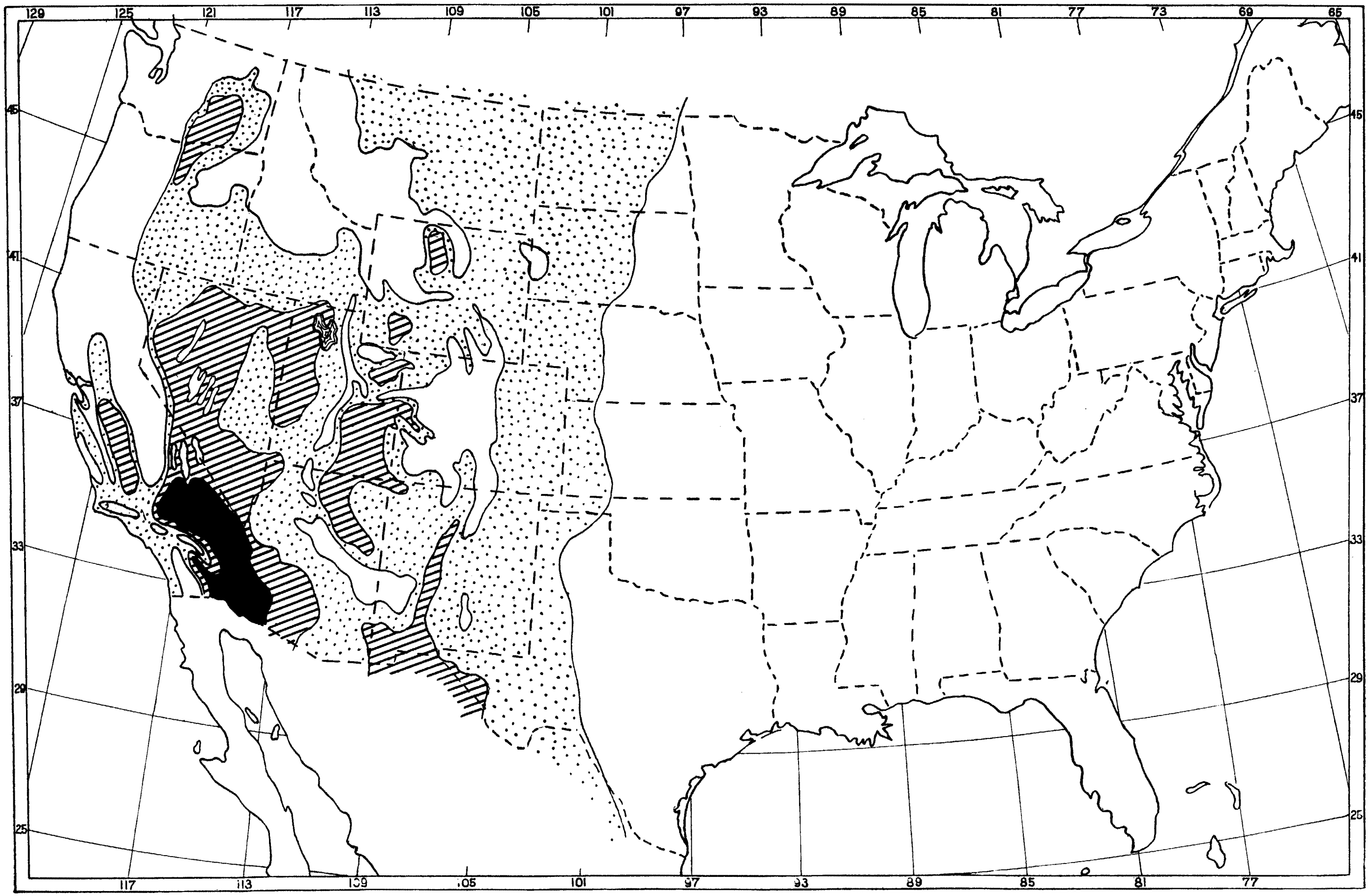

FIG. 1—The arid regions of the United States. Scale, 1:25,000,000.

Black indicates *desertic* conditions (a rainfall of less than 5 inches a year); ruled lines, *arid* conditions (5 to 10 inches); and dots, *semi-arid* conditions (10 to 20 inches). The semi-arid area contains most of the regions—only a small part of the whole—where irrigation or dry farming is possible. The precipitation of the entire shaded area, about 1,000,000 square miles in extent, may be called *scanty*.

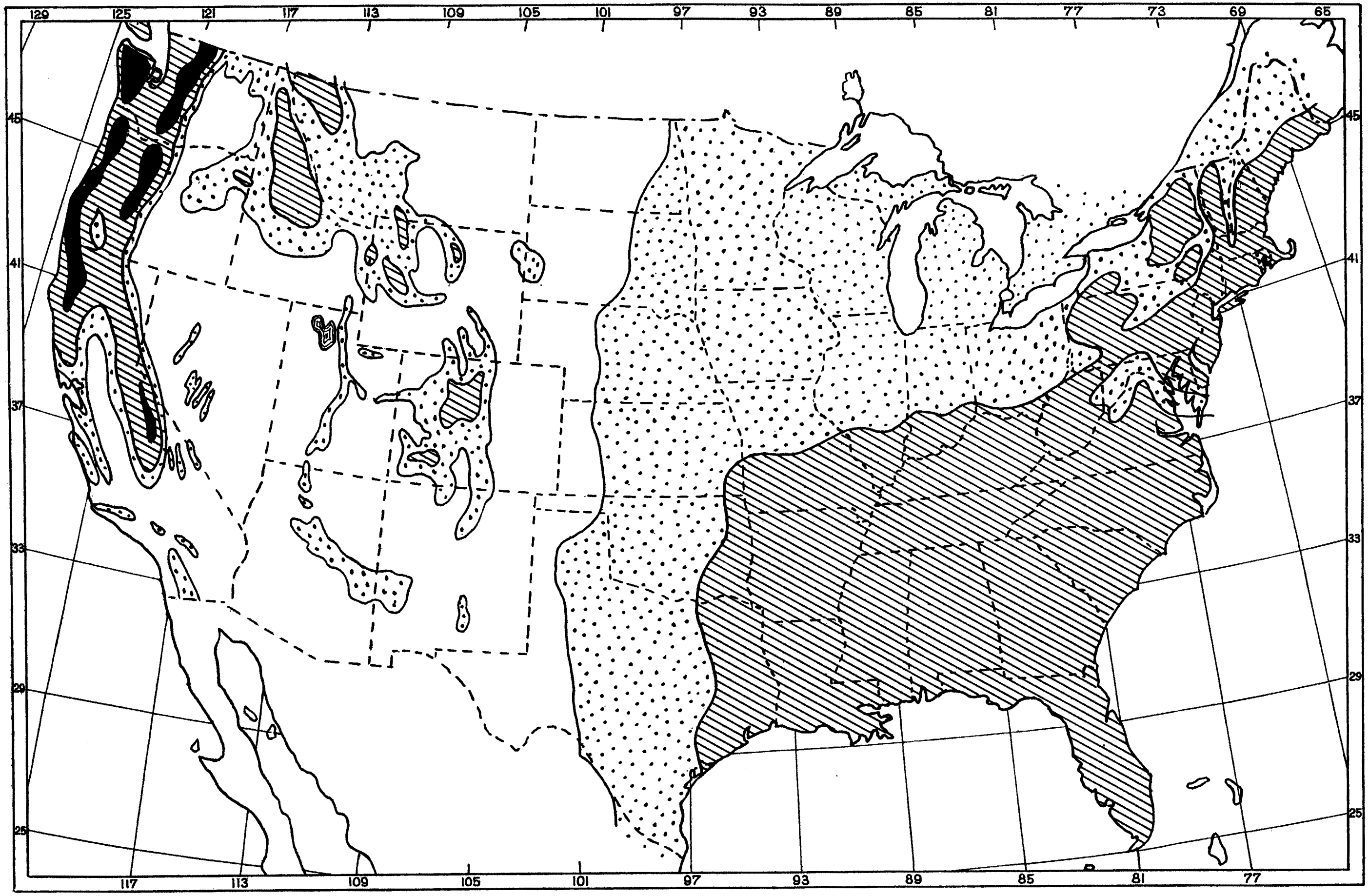

FIG. 2—The humid regions of the United States. Scale, 1:25,000,000.

Black indicates *excessive* rainfall (over 80 inches a year); ruled lines, *abundant* rainfall (40 to 80 inches); and dots *sufficient* rainfall (20 to 40 inches). The black areas are uninhabited mountains, which promise enormous water-power for the future, however. On the other two areas live the mass of the American people, on farms, or in cities or towns.

above 7,000 feet. Above the two highest gages are 4,500 feet of mountain slopes without measurements. Here the Weather Bureau contents itself with saying the precipitation is 15 inches, plus.

A. H. Thiessen, section director for the Bureau at Salt Lake City, says on a leaflet map entitled "Normal Annual Precipitation for Utah" that the rainfall "varies from 6 to 25 inches annually at stations between 2,800 and 7,000 feet, and it is probable that as much as 30 inches or more falls at some places at the higher levels." On what does Director Thiessen base this probability for the slopes above the gages? Upon the same facts, one supposes, that caused Mr. Gannett to put a modest 20-inch isohyetal line there—namely, the mountain vegetation and the mountain streams, which could not be maintained by the amounts of rain that fall at the levels of the gages. Gannett's map runs the 20-inch line along the higher slopes of the range. If anything, it understates the truth. The geographer cannot spare this line, especially in view of the considerations set forth below, which make 20 inches a critical value. The Weather Bureau map in the "Statistical Atlas" puts 40 inches on the Sierra Nevada, and also on the Cascades. Gannett has 80 inches and 100 inches. Perhaps the most significant contrast between the two maps is on the White Mountains of New Hampshire. The Weather Bureau map does not mark them with any local increase of precipitation, but its 40-inch isohyet passes through them. Gannett puts on his map, which is considerably smaller, local isohyetal lines for 50 inches, 60 inches, and 70 inches. Special interest attaches to this case because it happens that the summit rainfall is accurately known. For fifteen complete years a station was maintained at the summit of Mount Washington. The average precipitation was 83 inches. Only twice did it fall below 50 inches.[3]

From a geographical point of view 20 and 80 inches are critical quantities, marking in a rough way the lower and upper limits of the precipitation suited to agriculture without irrigation and, therefore, to a wide occupation of the land with farms, towns, and cities. Other factors, of which evaporation and seasonal distribution are the most important, greatly influence the availability of a given amount of rain. But in a general way, 20 to 40 inches of precipitation may be called *sufficient* in our climate; from 40 to 80 inches will then be *abundant;* over 80, *excessive;* and less than 20, *scanty.* As the regions of excessive precipitation in the United States are limited, the facts may be set forth on two diagrams; one, of the grades of scanty rainfall, a diagram of *aridity;* the other, of *humidity,* on which the excessive rains are included with the sufficient and abundant. It is plain that these should be contrasted. If the maps are shaded for intensity, the shading of the two maps will grade in opposite directions.

---

[3] The reader who is interested in the different points of view of meteorologist and geographer as to the theory of constructing rain maps will find a symposium of views on the subject in the *Monthly Weather Rev.*, Vol. 30, 1902, pp. 205-243 (with the 1902 map by Gannett listed in footnote 1, another rainfall map by A. J. Henry, and a map showing relief, all on the same scale), though the writer cannot accept as his the opinions there ascribed to him on the basis of a communication of his on "The Reduction of Records of Rain Gages," previously published in the *Monthly Weather Rev.* (Vol. 29, 1901, pp. 499-500.)

On the aridity diagram the deepest tint will denote the driest grade and fall in the driest region. Figure 1 is such an aridity map. On it black is the tint of greatest aridity, less than 5 inches of rainfall in the year. The black region is fairly *desertic* like the Sahara, and measures some 35,000 square miles. It is almost wholly contained in southeastern California and includes the fast-drying-up Salton Sea and Death Valley, the lowest surfaces on the continent. It seems a little striking at first that the least rainfall should fall on the lowest surfaces, and both of them below sea-level. Possibly the Dead Sea, too, will recur to mind, with its surface 1,300 feet below sea-level. ''Here rain hardly ever falls.'' Of course it is active evaporation that keeps these water surfaces low and, in the case of Death Valley, where there are no inflowing streams, keeps the bottom of the hollow bare, 225 feet below the level of the sea. Blue skies and high evaporation go with rainlessness; so these spots may be said in a way to be low because they are dry. The bottom of Lake Superior (– 406 feet) is still further below sea-level. Only the rains that fill it lift the water surface so high that it overflows at the ''Soo.'' With desertic conditions its floor would be revealed as the lowest point of the continent. When water broke into the Salton sink from the Colorado, as happened a few years ago, it was rapidly lowered by evaporation, and the Sea will dry up again in a dozen years.

Next in aridity to the black area is the shaded one indicated by ruled lines, covering about 250,000 square miles in patches that always lie between mountain ranges—between the Cascades and the northern Rockies, between the Sierra Nevada and the Wasatch, between the Wasatch and the Colorado Rockies, between the Coast Ranges and the Sierra Nevada in California, and among the ranges of Montana and New Mexico. The precipitation in this area is from 5 to 10 inches, and the country is distinctly *arid,* with agriculture dependent on irrigation. Evaporation is active, and there is little promise for the future.

The lowest grade of aridity, a rainfall of 10 to 20 inches, is represented on the map by the dotted areas. They measure in all about 720,000 square miles, and form the lower portions of the great plateau on which stand the Rockies and the Basin Ranges between the 100th meridian and the Sierra Nevada and Cascades. This region is *semi-arid* in character. Portions of it in the north are susceptible of dry farming, and smaller portions both in the north and in the south can be supplied with water for irrigation. It is the most promising part of the arid regions and has the chief opportunity for future expansion now left within our domain. About half of these semi-arid lands are within the Great Basin, about half lie in a broad belt along the eastern front of the Rockies.

The blank remaining portion of the country is needed on the diagram to give proportion to the region of scanty rains. The blank surface emphasizes by its presence the various shadings of the arid region.

Figure 2 shows the contrasted diagram of humidity. The emphasis is here reversed. The arid lands of the first diagram are all blank, and black, the deepest shade, represents *excessive* rainfall (over 80 inches). As an upper limit of availability for man it might have a diagram to itself were it not so restricted in area in the United States and so scattered. It lies wholly on the northern Coast Ranges and the Cascades, with a touch on the Sierra Nevada. The area where this intense precipitation occurs may be half as large again as that of desertic rainfall. Being steep mountains, it abounds in power that the swift down-pouring water generates, When the coal fields of the world are exhausted, here is an unending motive-power for industry which must some day give the Pacific coast a complete dominance in our country. Most of Figure 2 is covered by the shades for *abundant* and *sufficient* rainfall: abundant (40 to 80 inches), represented by ruled lines, an area of nearly 1,000,000 square miles in the southeast, on the Atlantic coast, in the Pacific coast valleys, and on some of the highest ranges of the Rockies; and sufficient (20 to 40 inches), the dotted area of over 1,000,000 square miles in the Great Lakes region, the prairies of the western part of the Mississippi valley, and the Rocky Mountains. In these two rainfall regions, especially the latter, live the great mass of the American people. There are most of the farms, there are twenty-nine of the fifty cities of the United States and Canada with over 100,000 people (and most of the other twenty-one are near the Atlantic coast, where the rain is little over 40 inches).

Figures 1 and 2 draw all their facts from Gannett's map. They do not exhaust it, for they omit no fewer than twelve of its isohyetal lines; yet it is believed that they help the eye to perceive and interpret some facts that the geographer wishes selected from the mass of details that must be stored in a general map of annual precipitation. In addition to the biologic significance of the facts selected and brought into relief is their genetic importance, distinguishing the aridity of the basins, which the air can only enter by descending, from the humidity of the uplands, where the air moves upward. For the professed student a detailed chart of isohyetal lines is essential, quite as a dictionary to a student of literature; but such maps do not appeal to the average man, for they do not speak plainly to him. Even the student may find that such diagrams as those here offered may help him master essential facts. They may merely serve to remind him of the conclusions of his thinking, just as a photograph of a friend hardly tells us what our friend is like, but rather serves to remind us of the pleasure we have had in knowing him.